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MELBOURNE AUSTRALIA

Examining the accuracy and in-game performance effects between pre- and post-performance routines: A mixed methods study

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Abstract

Objectives: Researchers have identified that pre-performance routines improve performance under pressure, yet have not investigated the effects of post-performance routines. Thus, the purpose of the current study was to examine whether the type of performance routine training could improve tenpin bowling accuracy and in-game performance.

Design: A mixed-method design was adopted, whereby the impact of a performance routine intervention on performance accuracy and in-game performance was examined. This was followed by participants completing semi-structured interviews which explored the perceived effect of those routines.

Method: Thirty-six experienced tenpin bowlers completed 30 accuracy shots pre- and post-intervention training, with league scores obtained for in-game performance comparison. Four groups (i.e., pre-performance routine [PPR], post-performance routine [POST], combined pre-post routine, and a control group) practiced 12 games across four weeks while listening to the group specific routine instruction on an iPod.

Results: It was noted that accuracy improved (albeit non-significantly) for the PPR and combined pre-post routine group, but not the other groups. Critically, all intervention groups (PPR, POST & COMBO) improved in-game performance. The qualitative data indicated that both the PPR and POST was perceived to influence positively performance, attentional and emotional control, self-awareness, self-confidence, motivation. The PPR was also considered to enhance a state of readiness, and perceived control.

Conclusions: Results indicate that the PPR training enhanced accuracy and in-game performance, with the POST training acting as a supportive role for in-game performance as

- 1 evidenced by the qualitative and quantitative data. Future research should continue to investigate
- 2 the effects of POSTs.
- 3 Keywords: Pre-shot routine, post-shot routine, self-regulation

**Examining the accuracy and in-game performance effects between pre-
and post-performance routines: A mixed methods study**

Applied sport psychologists attempt to improve athlete performance, in part, by educating them to become more aware of performance inconsistencies, apply volitional control to reduce negative spontaneous reaction to competitive situations, and use more adaptive self-regulation (Hemmings & Holder, 2009). Self-regulation is the management of cognitive, emotional, motivational, and social processes to make decisions, engage in behavior, and process stimuli in the pursuit of goals (Cameron & Leventhal, 2003). Baumeister, Vohs, and Tice (2007) explain that self-regulation is any effort by an individual to alter thoughts, emotions, and actions in accordance with his/her desires. Therefore, functional self-regulation facilitates desirable behavior because the individual resists inappropriate impulses and persists with correct behavior (Baumeister, Heatherton, & Tice, 1994).

One self-regulation strategy offered by applied sport psychologists to improve their athletes' attentional and emotional control is a pre-performance routine (PPR). Moran (1996) states that a PPR is a sequence of task-relevant thoughts and actions an athlete systematically engages in prior to performance of a sport skill. Moran's definition is the most widely adopted among studies investigating PPRs (see Cotterill, 2010 for a review). To date, PPRs have been adopted predominantly to improve the performance of closed and self-paced tasks (e.g., putting in golf, free-throw shooting in basketball, or executing a ten-pin bowling delivery).

Researchers have provided equivocal results regarding the effectiveness of PPRs, with novices appearing to benefit the most (Beauchamp, Halliwell, Fournier, & Koestner, 1996; Crews & Boutcher, 1986; McCann, Lavalley, & Lavalley, 2001); while studies involving experienced athletes have indicated mixed results following PPR training (e.g., Boutcher & Crews, 1987; Cohn, Rotella, & Lloyd, 1990; Kingston & Hardy, 2001; Lobmeyer & Wasserman, 1986; Marlow, Bull, Heath, & Shambrook, 1998). Cohn et al. (1990) for example, examined the effects of a cognitive-behavioral PPR intervention on three male collegiate golfers during

1 competition and reported that although the intervention increased PPR adherence, there was no
2 immediate performance increase. During subsequent interviews however, the participants
3 expressed immediate subjective improvements in unobservable mental skills, such as
4 concentration and confidence. Though such perceptions were not directly observable in objective
5 performance scores. Follow-up testing after four months verified an improvement in all three
6 players' performances, with the golfers' interview data indicating they believed the PPR was
7 beneficial. These results should be viewed with caution however, for the perceived benefit may
8 be due to other variables such as physical practice. Marlow et al. (1998) also found the penalty
9 shot accuracy of three experienced water polo players increased by between 21% and 28%
10 immediately following the implementation of a PPR. Furthermore, Velentzas, Heinen, and
11 Schack (2011) investigated whether two types of routine methods (i.e., imagery or introduction
12 to a PPR), trained over a 7-week intervention period could improve volleyball serving
13 performance. Velentzas et al. found that both intervention groups improved serving performance
14 from pre- to post-intervention, with the imagery group being the most effective routine training.
15 In addition, it has also been established that PPRs may lower arousal levels (Boutcher & Crews,
16 1987), increase intrinsic motivation, reduce negative introspection (Beauchamp et al., 1996), and
17 increase attention to task (Cohn et al., 1990; Cotterill, Sanders, & Collins, 2010).

18 A number of researchers (e.g., Anshel, 1995; Bartholomew, 2003; Dale, 2004) have
19 posited that a PPR is a suitable intervention to aid athletes in coping effectively with pressure
20 during real-world competition. Mesagno, Marchant, and Morris (2008) employed a single-case
21 design method to demonstrate improved performance under pressure of three "choking-
22 susceptible" (i.e., likely to experience "choking under pressure") ten-pin bowlers using an
23 extensive PPR. The extensive PPR included modifying or incorporating cognitive and behavioral
24 elements into their pre-existing PPR, such as a deep breath, cue word and behavioral steps. Due
25 to limitations associated with a single-case design, Mesagno and Mullane-Grant (2010)
26 subsequently conducted a follow-up experimental study with a larger cohort, to assess which

elements of the PPR were most effective for improved performance. Participants were assigned into one of five groups: deep breath (i.e., took three diaphragmatic deep breaths); cue word (i.e., developed a cue word to focus attention to the task); temporal consistency (i.e., counted down aloud from five to maintain temporal consistency); extensive PPR (i.e., educated on extensive PPR similar to Mesagno et al., 2008); and control (i.e., no intervention training). Results indicated the extensive PPR group improved performance under pressure more than groups using only independent PPR elements, with the control group decreasing performance. In support of Mesagno and Mullane-Grant (2010), Hill, Hanton, Matthews, and Fleming (2011) demonstrated, in a longitudinal study of elite golfers, that a PPR could alleviate choking under pressure as part of a mental skills program through increased perceived control, lowered debilitating anxiety, and improved focus. Collectively, these studies indicate a PPR may be an effective intervention to improve in-game performance when pressure may be heightened.

Despite the considerable research attention exploring the effectiveness of PPRs on performance, few studies have investigated behavioral or psychological routines undertaken after performance execution (i.e., post-performance routine). We define a post-performance routine (POST) as a series of behavioral or psychological strategies undertaken after performance execution, yet prior to the PPR of the next performance attempt. Hill, Hanton, Matthews, and Fleming (2010) were the first to identify that the use of POSTs may be a mechanism to improve performance under pressure. Hill et al. interviewed six elite golfers who frequently experienced choking under pressure and five elite golfers who frequently excelled under pressure. They found those golfers who excelled under pressure, performed a consistent POST after each shot, which tended to include constructive task-related reflection, followed by a behavioral response (i.e., removal of glove) that triggered attention to be directed towards the next shot. However, those who experienced choking under pressure appeared to rarely or intermittently complete a POST. Much of the psychological turmoil that athletes encounter during competition may stem from maladaptive thoughts associated with unacceptable shot performance, which in turn may lead to

1 misdirected concentration and emotional upheaval during the POST. As Hill et al. explained,
2 “participants who excelled under pressure were less self-critical (than “chokers”) after poor
3 performances, as they accepted mistakes and used negative experiences to improve their
4 game...interventions that encourage the “chokers” to accept poor performances...could prove
5 beneficial” (p. 235).

6 Similarly, Oudejans, Kuijpers, Kooijman, and Bakker (2011) used concept mapping to
7 analyze written responses of seven expert athletes from a range of sports about their focus of
8 attention in high-pressure situations. Concept mapping involves a sequence of group activities
9 focused on qualitative analysis that provides thematic clusters of aggregated text across
10 participants. Oudejans et al. found that worries related to negative thoughts and uncertainty /
11 doubt were two of the five clusters with the highest importance rating of cognitions associated
12 with performance under pressure, and thus in-game, real-world cognitions. The Oudejans et al.
13 study did not differentiate when these worries occurred, nevertheless, it would be logical that
14 these worries could be present either prior to, during, or following skill execution within real
15 world (rather than laboratory based) competitions.

16 From the aforementioned research, using POSTs as an intervention could improve coping
17 responses and minimize negative reactions to skill errors that lead to self-deprecating cognitions
18 and performance inconsistency, by providing athletes a central attentional focus after
19 performance execution. This could prove particularly helpful for athletes who have a tendency to
20 be highly self-critical (i.e., dysfunctional perfectionists), and who suffer from low confidence
21 and poor attentional control. Thus, it could be inferred that focusing on a routine may decrease
22 negative introspection, increase functional self-regulation and improve performance outcomes
23 (Singer, 2002). Further research on POSTs and their effectiveness for in-game performance (and
24 under pressure) would be advantageous. Such information could help applied sport psychologists
25 augment their psychological skills repertoire to implement empirically tested and validated
26 interventions related to after shot psychological recovery.

Purpose and Hypotheses of the Current Study

Through a mixed-method approach, the purpose of the current study was to examine whether the type of performance routine training (e.g., pre- or post-performance) could improve tenpin bowling accuracy and also in-game performance using real-world competition (i.e., league averages). It was hypothesized that the PPR, POST, and combined (i.e., PPR & POST) training groups would perform more accurately, and would improve in-game performance after a four-week intervention training period, compared to a wait-list control group. Thereafter, the perceived effects of the PPR and POSTs were explored through individual semi-structured interviews.

Method

Methodology

A mixed-method design was adopted to address the aims of the study, in which inferences and conclusions were drawn from the collection and analyses of both quantitative and qualitative data (Tashakkori & Creswell, 2007). By converging quantitative and qualitative methods in this manner, the strengths of both approaches are maximized and their limitation minimized, to provide a comprehensive analysis of the research problem (Creswell, 2003).

Participants

Thirty-six league bowlers ($M_{age} = 40.50$, $SD = 14.72$), with a reported bowling league average between 142 and 207 ($M_{average} = 179.03$, $SD = 17.10$) for at least 24 games, participated in the study. A league average of between 140 and 210 was necessary to represent intermediate to sub-elite bowlers because novices (below 140 average) may not be able to apply the POST procedures due to inconsistency, and elite bowlers (above 210 average) were likely to have relatively consistent PPRs and a ceiling performance effect might occur. A demographic questionnaire was completed prior to testing as a screening device for bowling experience (i.e., league average) and sport psychology training. Participants were untrained in sport psychology principles with only six suggesting they had “attended group workshops with a sport

psychologist”, though they did not explore / discuss performance routines specifically. At least one participant who had received sport psychology training was included in each of the groups (i.e., 2 PPR, 2 POST, 1 combined pre-post performance routine, & 2 control group), and so is unlikely to act as a confounding variable.

Equipment

Standard bowling equipment and facilities similar to Mesagno et al. (2008) were used. The audio recording of the PPR and POST (group specific instructions) was recorded to a “clip on” Apple Ipod shuffle with earphones (2 GB) so it could be attached to the participant’s clothes, and listened to during the intervention training phase.

Measures

Demographics questionnaire. Demographic data including age, gender, tenpin bowling experience (e.g., whether bowling in a sanctioned league, number of leagues per week, and highest league average), and sport psychology training (e.g., worked with a sport psychologists in any capacity) were recorded.

Task and performance measure. Tenpin bowling was chosen as the experimental task because it is a self-paced closed skill that is conducive to PPRs and POSTs. Furthermore, routines may have a direct influence on performance because the impending shots are taken quickly (if a spare is attempted after the “strike” shot) and only short breaks are allowed between frames. Therefore bowlers are required to perform soon after errors in performance execution.

The accuracy task was identical to that used within the Mesagno et al. (2008) study, whereby participants attempted shot attempts at a target on the bowling lane. Bowlers are usually instructed to focus attention at a target 15 feet (e.g., arrows) rather than 60 feet (i.e., the pins) away for easier identification of targeting and improved accuracy (Wiedman, 2006). Thus, absolute error, in centimeters (cm), from center of the target to center of the ball track was examined. Mean absolute error (MAE) for all shot attempts was the dependent variable; reduced

MAE indicated improved accuracy (the reader is referred to Mesagno et al. for additional details).

Training groups

Participants were randomly allocated into one of four training groups: PPR, POST, combined pre-post-performance routine, or wait-list control. The PPR group involved participants developing, or modifying their existing PPR. Boutcher (1990) advised that PPRs should involve a series of physiological, psychological, and behavioral steps. Within the PPR, optimal arousal levels (e.g., deep breaths), behavioral steps (e.g., wiping the ball off with a towel, watching their foot slide into the correct position on the approach, etc.), attentional control (e.g., focusing on a target), and cue words (when needed) were considered for inclusion into the PPR. Since the PPR was personalized for each participant, these steps were possible elements to include, but were not necessarily uniform across all PPR and combined group participants. The first author (a certified tenpin bowling coach and sport psychology consultant) attended the pre-intervention test sessions (see the *Procedures* section for test session information) and identified appropriate components of the PPR while taking extensive notes on each participant's routine. Considering each bowler's PPR was individualized and existing routines may be more inconsistent for novice compared to experienced bowlers, PPR modifications were tailored to each participant's individual routine with no standardized routine implemented. While developing the behavioral steps for the routine and to ensure understanding, the routine was practiced to the satisfaction of both the participant and the first author, and terminated when the participant performed five repeated "shadow shots" (i.e., shots without the ball) using the PPR.

The POST group used a psychological POST, whereby each participant answered a series of questions, which related to the previously delivered strike shot. The series of questions was developed by elite level coaches ($n = 2$; average coaching experience = 24.5 years) and the first author. This sequence of questions was perceived by the elite coaches (but has not yet been empirically tested) to help the bowler remain psychologically composed, accept the effectiveness

of performance execution, and make appropriate target alignment adjustments to remain closer to the “pocket” (i.e., area at the pins where strikes are more likely).

The series of questions included (in sequential order): 1) Did I execute the shot well? 2) Did I hit the target in which I was aiming? and 3) Did the ball hit the “pocket”? If the participant answered “no” to any of these questions, then no target alignment adjustment was made (e.g., move feet, move target, change bowling balls etc., to change angle or direction to the pocket) and better performance execution was attempted on the next strike shot. If the participant answered “yes” to all of these questions, then the question, “Where did the ball hit the pins?” should be answered to identify which type of target alignment adjustment to make. Similarly to the PPR, the POST was explained to the participant in enough detail that he / she understood the questions, and knew when / how to make possible target alignment adjustments when answering the question, “Where did the ball hit the pins?” Accordingly, the process adopted within the POST was aligned to the reflection phase of Zimmerman’s (2000) self-regulation theory, whereby participants were encouraged to take responsibility for their own learning through the use of strategies that encouraged evaluation of their performance.

The combined pre-post performance routine group (hereafter labeled simply as “combined”) completed both the PPR and POST training as described above. The wait-list control group completed the intervention training phase without PPR or POST education.

Procedures

Upon receiving approval from the lead author’s University Research Ethics Committee, participants were recruited from tenpin bowling leagues ($n = 3$) in an Australian major city, by asking league officials for their consent. Volunteer bowlers were addressed prior to a league competition session / event, and those recruited completed an informed consent form and demographics questionnaire to determine eligibility (i.e., a league average below 210). Participants completed the study independently and took part in three phases: pre-intervention test, intervention training, and post-intervention test phases.

1 The pre-intervention test phase involved 30 attempts (with a 2-minute break between
2 blocks of 10 shots) at a target on the bowling lane to measure accuracy, with an independent
3 research assistant (i.e., blind to the purpose of the study) completing data collection. Immediately
4 following the pre-intervention test, an individualized (but group-specific) routine education
5 session was offered (i.e., participants were educated about his / her individually tailored routine
6 based on the intervention training group in which they were allocated) to each participant in the
7 intervention training groups (i.e., PPR, POST, or combined). Audio recording of each bowler's
8 individual routine was made for the participant to use during the four-week intervention training
9 period. The audio recording provided instructions, at a comfortable speed, of the step-by-step
10 routine for each participant in the intervention groups. After the education session, the recording
11 was transferred to an Apple Ipod shuffle for each participant to use throughout the intervention
12 training phase. During the intervention training phase, participants practiced three games per
13 week over four weeks (12 total games) while listening to their acquired routine on the Apple
14 Ipod.

15 The post-intervention test phase was identical to the pre-intervention test phase with the
16 exception that participants in the intervention training groups implemented their performance
17 routine training during post-intervention accuracy test.

18 To investigate in-game performance changes, and therefore real-world performance
19 responses, the 12 competition (i.e., league-based) games prior to the pre-intervention test phase,
20 and 24 competition games immediately following the post-intervention test phases, respectively,
21 were obtained from the league secretary. The 24 games post-intervention training were divided
22 into two separate 12 game sets, with the initial 12 games hereafter referred to as post-
23 intervention training and the final 12 games called follow-up intervention training. The follow-
24 up intervention training games were obtained to determine the robustness of the routine training.

Interviews were conducted immediately following the post-intervention test to explore in further detail the perceived impact of the intervention training. No interviews were conducted with the wait-list control group.

Training Logbook

During the intervention training phase, all participants completed an intervention training logbook after each week of training and submitted their logbook to the first author. Participants logged the number of bowling games practiced, which confirmed they completed the required training during the intervention training phase. The logbook also included the number of extra practice games participants completed above the intervention training games, to determine if all participants were practicing, or competing, equally during the training weeks. In addition, participants who received an Ipod answered the question, *How much did you pay attention to the Ipod instructions during the training games?* Participants answered the question on a 10-point scale ranging from 1 (*I did not pay attention to the Ipod at all during training*) to 10 (*I paid attention to the Ipod instructions on all shots of training*) for each of the four training weeks they used the Ipod.

Individual Interviews

An interview guide of open-ended questions was derived from the relevant PPR and performance literature and finalized after consulting two sport psychologists. The purpose of the interview was to explore the perceived emotional, cognitive, behavioral effect of the intervention training on performance accuracy, and perceived in-game (i.e., league average) performance before and after routine training. In line with the recommendations of Teddlie and Tashakkori (2009), the interviews completed within this mixed methods study were semi structured. That is, participants were encouraged to articulate in detail, and from their own viewpoint, the perceived effect of the pre- and / or post-performance routines on their performance. The questions were open ended (i.e., prefaced by how? why? in what way?) and probes were used to gain further insights where necessary (e.g., can you tell me more about that?). The interview schedule is

available on request from the lead author. Interviews were completed by the lead author, and ranged from 16 to 54 minutes with clarification and elaboration questions stimulating participant responses (Patton, 2002).

Results

Due to injuries to three participants during the study (2 PPR & 1 POST participant), only 33 participants were included in the analyses. Initially, to identify that ability level was similar among groups, a one-way Analysis of Variance (ANOVA) was conducted on the reported league average prior to study involvement. To strengthen the results of the performance data and rule out other possible confounding variables, separate one-way ANOVAs were conducted for total number of leagues and total extra games bowled during intervention training per week, total games practiced with Ipad during the training intervention phase, and average Ipad use for intervention groups during the intervention training phase. Then, a 4 (Group: combined, PPR, POST, control) \times 2 (Test: pre-, post-intervention test) mixed-design ANOVA with repeated measures on the Test factor was conducted for mean absolute error (i.e., performance accuracy). Finally, a 4 (Group) \times 3 (Test: pre-, post-, follow-up intervention test) mixed-design ANOVA with repeated measures on the Test factor was conducted on mean league scores of the 12 games collected in each phase. Partial eta squared (partial η^2) was used as an indicator of effect size for ANOVA calculations (Tabachnick & Fidell, 2007). Partial eta squared of 0.01 indicated a small effect size, 0.059 a medium effect size, and 0.138 a large effect size (Cohen, 1988). An alpha level of .05 was set for all statistical tests.

Homogeneity of Groups

The reported league average indicated no significant Group differences, $F(3, 32) = .04, p > .10$, partial $\eta^2 = .004$, indicating that groups were equal in initial bowling ability prior to involvement in the study.

Homogeneity of Possible Confounding Variables

The total number of leagues bowled per week indicated no significant Group differences, $F(3, 32) = 2.12, p > .10$, partial $\eta^2 = .18$. The total number of games practiced with the Ipod during the training intervention phase indicated no significant Group differences, $F(3, 32) = 1.37, p > .10$, partial $\eta^2 = .12$. The total extra games practiced during the training phase also indicated no significant Group differences, $F(3, 32) = 0.64, p > .10$, partial $\eta^2 = .06$. The average Ipod use for the intervention groups during the training phase indicated no significant Group differences, $F(2, 23) = 0.15, p > .10$, partial $\eta^2 = .01$. These results indicate that the groups were similar in amount of games bowled during the intervention training phase and each group's attention to the Ipod was similar for the intervention training groups and that performance could be equated to the training groups' performance differences.

Performance Accuracy

Initial exploratory analysis for performance accuracy indicated that two participants (one in PPR, and one in control group) were outliers in the post-intervention MAE score, thus, those participants were deleted from the performance accuracy analysis. From the remaining participants ($n = 31$), performance results indicated no significant Group, $F(3, 27) = 1.05, p > .10$, partial $\eta^2 = .10$, or Test main effect, $F(1, 27) = 2.21, p > .10$, partial $\eta^2 = .08$. There was also no significant interaction, $F(3, 27) = 1.41, p > .10$, partial $\eta^2 = .10$. Noteworthy is that the PPR and combined groups improved accuracy the most (see Table 1 for descriptive statistics).

****Insert Table 1 here****

In-Game Performance

Analysis of in-game performance, via league scores, indicated no significant Group main effect, $F(3, 29) = .22, p > .10$, partial $\eta^2 = .02$, or significant Group \times Test interaction, $F(6, 58) = 1.04, p > .10$, partial $\eta^2 = .10$. There was, however, a Test main effect, $F(2, 58) = 3.60, p = .03$, partial $\eta^2 = .11$. Pairwise comparisons indicated that league scores in the post-intervention ($M = 184.76, SD = 17.37$) and follow-up intervention tests ($M = 184.53, SD = 16.76$) were

significantly different to performance scores in the pre-intervention test ($M = 179.50$, $SD = 19.73$), with no significant difference between the post-intervention and follow-up intervention tests. The difference in league averages was largely because of the intervention groups improving their average after the intervention training in comparison to the control group.

Interview Results

The interview data were analysed through qualitative content analysis (see Schreier, 2012 for a review), which is a systematic means of describing a phenomenon, while identifying relationships between concepts. The analytical process broadly followed the steps advocated by Mayring (2010). That is, interviews were transcribed verbatim and read several times to ensure familiarisation. Thereafter, raw data quotations / phrases were extracted from the transcript, providing pertinent examples of the perceived effect of PPR and POST on participants accuracy and in-game performance. Any raw data quotations with similar meaning were subsequently placed into overarching codes, which in turn were organized and collated further into sub-categories to construct an increasingly explicit representation of the participants' experience of the intervention. During the analytical procedure, bracketing was employed. This process involves the researcher becoming aware of any assumptions and predispositions of the subject material they may have, and setting them aside to avoid them unduly influencing the research outcomes (see Giorgi & Giorgi, 2003). Transcripts with the emergent codes / categories were sent to the participants for member checking.

The interviews revealed seven over-arching themes regarding the perceived effect of PPR and five for POST. Several themes were similar for both PPR and POST (see Table 2 and Table 3 for summaries), with the effects of the routines independent of whether they were adopted as individual strategies or used in combination (i.e., the combined pre-post performance routine group). The themes included: *performance, attentional and emotional control, self-awareness, self-confidence, motivation, a state of readiness* (PPR only), and *perceived control* (PPR only).

****Insert Table 2 and 3 here****

Of the 24 participants who were interviewed [$n = 7$ PPR; 8 POST; 9 combined], 23 perceived the adoption of a routine (i.e., within the PRE, POST, or combined groups) had improved their performance, primarily through increased consistency. For example, Bill¹ explained, *“I was stringing the strikes together more consistently because of the routine...Instead of getting 2 or 3 strikes in a row, I would be getting 5 or 6”*. Indeed, Tom indicated the PPR maintained consistency by preventing catastrophic performances (i.e., a considerable and dramatic decline in performance standard). For participants who had adopted a POST, such consistency was associated closely with an increased effectiveness of identifying and attending to required technical, target alignment adjustments. As summarized by Carl:

I used to just throw the ball...and if it was wrong just carry on doing the same thing, so it would go downhill from there. Now, I go through the routine. If something was wrong, I think what was wrong? And adjust...I am definitely benefiting.

All participants from each group (i.e., PPR, POST, or combined), who perceived a performance improvement, primarily attributed it to enhanced *attentional and emotional control*. With regards to attention, the routines enhanced task-related focus. That is, the PPR encouraged an external-narrow focus prior to and during skill execution (i.e., *“I was probably more target orientated in the last four weeks then I have been maybe in the last four years... in the past... my measure would be okay, how well did I execute that shot”*), while the POST initiated a focused reflection on necessary target alignment adjustment after skill execution. This in turn allowed participants to block out distractors that would have previously affected their performance detrimentally (including anxiety-related thoughts and self-presentational concerns). Such enhanced attentional control was considered particularly beneficial after a mental / performance error. For example, Anna explained, *“I have the [pre-performance] routine running though my*

¹ All participant names are pseudonyms.

1 *head, so I turn off from everything that's happening around me...Previously, I would be thinking*
 2 *about what's going on around me...and what I'm doing wrong".* Another participant, Danielle
 3 suggested that, "*[after an error] instead of focusing on being a bad bowler whilst taking the next*
 4 *throw...I'm thinking about the [pre-performance] routine...My thoughts are directed to re-*
 5 *focusing on that".* Similarly, when discussing the POST, Cheryl explained, "*I now focus on*
 6 *something other than the emotions I may feel after the shot...So regardless of what's happened, I*
 7 *would think about whether I executed that...whether I hit this....and that helps me stay focused*
 8 *on the game".*

9 Furthermore, 15 out of 16 participants who received a PPR [$n = 7$ PPR; 8 combined]
 10 identified it had improved their attentional control by either preventing the explicit monitoring of
 11 skill execution (i.e., directly focusing on the technique and attempting to consciously control the
 12 skill execution), and / or enabling re-focus in-between shot attempts. Interestingly, 50% of
 13 participants identified their routine had lowered their performance initially, due to the distraction
 14 it caused. Thus, for many, perceived improvements only occurred once the routine was
 15 embedded (after approximately two of the four intervention training weeks). Understandably,
 16 participants in the combined pre-post performance routine group predominantly (though not
 17 exclusively) required a longer period of time before they experienced the associated benefits of
 18 the routines. Notably, some of the combined group participants explained that they focused more
 19 on the PPR during the routine training sessions than the POST, which may indicate that the PPR
 20 was adhered to more than the POST, leading to the performance differences among groups.

21 The one participant, Simon, who perceived the PPR did not improve performance,
 22 admitted he had not adhered to the PPR, was sceptical about psychological skills training, and
 23 was uncomfortable using the Ipod during training: "*...the Ipod thing, it just kept falling out [of*
 24 *my ears], so I just gave up. I just couldn't do what it said. I don't think I've learnt anything to be*
 25 *honest. It's [PPR] nothing that would benefit me."* Curiously, though, Simon improved his
 26 league average considerably after the intervention training (by 28 pins).

Concerning *emotional control*, most participants [$n = 5$ PPR; 7 POST; 7 combined] suggested the PPR and POST alleviated negative emotions (e.g., frustration & anxiety) while encouraging positive emotional responses (e.g., relaxation). Sam, who adopted a PPR explained: “*It helped me re-group and start again. I used to get upset when I messed up, so I’d miss another shot and get worse. Now, I focus on the routine...on what I have to achieve...it helps me stay calm.*” Similarly, when recalling the effects of a POST, Bobby suggested, “*It deals with my reactions of a strike and non-strike...It calms my emotional side down, so I get back to focusing on asking different questions about what has just happened. It’s definitely made me a lot calmer*”. Regarding anxiety, a number of participants [$n = 5$ PPR; 2 POST; 3 combined] recognized the PPR and POST was helpful because it reduced its debilitating effects. Terry explained, “*The [pre shot] routine deals with my butterflies...Last night I had two occasions where I got strikes at the end of the game. It [PPR] meant I could screen out those pressures...just execute the shots properly and not worry about the result*”. Moreover, the post-shot routine “*helped me get on top of those negative thoughts*”.

The qualitative data indicated that the routines had affected 14 participants’ [$n = 3$ PPR; 6 POST; 5 combined] *self-awareness*, which enabled an enhanced management of their current performance, while also informing strategies for future self-development. When reflecting on the role of PPR, Steve explained, “*It made me think about what I am doing and why; whereas before, I just bowled.*” Another participant, Helen, stated, “*...the routines made me aware I was not concentrating before. I hadn’t realised....You then take the game more seriously...you then start to analyse yourself to look for improvement.*” Such improved self-awareness was particularly evident within the POST group for it specifically encouraged increased awareness of technical errors, “*Until using it [POST] I didn’t realise I was releasing it [the ball] wrong; [be]cause I was just throwing the ball down. It all makes sense now...and so I am now working on that with my coach*”. Similarly, Eddie explained:

1 So my [post shot] routine makes me notice if I am hitting the specific area of my target. I
 2 am now thinking about where I am throwing and how I can hit the pocket...how to
 3 improve each shot...I now adjust really quickly...and so learning how to bowl really well
 4 and consistently.

5 Interesting, Cheryl found the POST had initially been, “frustrating” and “stressful”, for although
 6 it enabled her to identify which aspect of performance required adjusting, she did not have the
 7 technical knowledge to make those corrections.

8 The majority of participants [$n = 6$ PPR; 5 POST; 5 combined] noted they experienced
 9 improved *self-confidence* as a result of the PPR and POST. Such raised confidence emerged
 10 from trusting and expecting the routine to encourage successful skill execution. The effect of
 11 PPR on confidence was summarized by Terry who explained, “*I focus on the pre-shot routine*
 12 *because I know it will get my **** [expletive] together, and so I then know I will strike out*”.

13 Such increased confidence was particularly notable after a performance error:

14 The first time I put a ball in the gutter [a very poor shot] it didn’t bother me as much as it
 15 would have before, as I realised it must have been a consequence of losing focus. I knew
 16 I just had to go back to my [pre-shot] routine, make sure I follow it. That meant I didn’t
 17 throw two bad balls...It was really reassuring.

18 A similar impact was noted with the POST, “*I feel so much more confident bowling because I am*
 19 *making adjustments when necessary. I step back every time, and think about my shot, and have a*
 20 *clear plan of action as a result*”. Importantly, it was recognized that the POST enabled
 21 constructive reflection after a performance error, which minimized participants’ self-criticism
 22 and so protected their self-confidence.

23 It was also reported by nine participants that the PPR and POST led to raised motivation.
 24 With regards to the PPR, it was suggested by Helen that, “*If I had thrown a few bad balls in the*
 25 *past, I would have given up, because I didn’t have any base to go back to. Now I have the routine*
 26 *to go to and it keeps me going*”. A similar example was offered from Carl within the combined

group, “*Thing is, I can actually do things to make it better...so by focusing on it [POST] and knowing I can make it better, I’m not going to give up*”.

Several participants [$n = 8$] also acknowledged the PPR encouraged a *state of readiness* prior to the task. It fostered a slower and more considered / planned approach for skill execution, and the opportunity to self-regulate emotions. As explained, “*I’m taking the deep breath, and then really thinking about my shot, and looking at my target. Instead of just getting up and bowling and throwing bad shot after bad shot. It slowed me down.*” Likewise, Terry reported, “*If I’m a bit anxious, I tend to rush and that’s when I miss. A pre-shot routine stops this*”.

Of the seven participants within the PPR group, five identified their performance had been affected as a result of the routine raising their levels of *perceived control*. Sam offered a summary of this process:

The routine is a set of rules to achieve a goal. You just focus on applying those rules every time. It’s like a protocol manual. No matter what the circumstances...or the lane conditions... that is the procedure. It is the best thing mentally...as you just focus on this...It makes me feel I am in control of what I am doing. I now know what I need to do, and if I do it repeatedly, I’ll have a good game.

Moreover, it was suggested that when a performance / mental error occurred, returning to focus on the PPR tended to increase levels of perceived control over the situation, emotions, and subsequent performance.

Finally, the data revealed that most participants within the PPR group also adopted their own POST that was predominantly an evaluation of their PPR and shot execution. Likewise, participants who were assigned to the POST group often developed a PPR that attended to the outcome of their POST reflection (i.e., they focused on technical adjustments). Accordingly, the qualitative data indicated a blurred line between the three participant groups, though recognizes the independent perceived impact of a PPR and POST on the participants and their performance.

Discussion

The aim of this study was to examine the effect of a pre- and post-performance routine on experienced ten-pin bowlers' accuracy and in-game performance. The findings indicated an increase (albeit non-significantly) in performance accuracy from pre- to post-intervention training for groups using the PPR. Critically, all intervention groups' in-game performance improved, in contrast to the control group. The in-game and performance accuracy of the PPR and combined groups improved more than the POST group, inferring that the PPR may hold primary responsibility for the performance effect, with the POST offering a supplementary supporting role. Thus, the findings offer further, ecologically valid, empirical evidence that a PPR can enhance athletic performance in a real world setting (Cotterill, 2010), and reinforce the preliminary suggestion that POST contributes to optimal performance (Hill et al., 2010).

Quantitative Performance Differences

For performance accuracy, those groups that were provided with the PPR training (in isolation or in combination with the POST) improved accuracy the most from pre- to post-intervention training, whereas the POST and control groups showed minimal accuracy changes. These findings are similar to other PPR studies (e.g., Marlow et al., 1998) who found that using a PPR improved accuracy on water polo penalty shooting accuracy. In their single-case design, Marlow et al. found percentage improvements, rather than statistical significance, for the participants who used the PPR. In the current study, where statistical significance could be obtained, the PPR groups did not show significant changes in accuracy. However critically, the intervention training had improved in-game performance from pre- to post-intervention, and also to the follow-up intervention test. Immediate in-game performance improvements were found in the current study with further effects occurring at the four week follow-up intervention test. Cohn et al. (1990) however, found no immediate improvements in performance but delayed improvements four months later. The current research was the first to investigate the retention effect of routines to determine the robustness of the training on in-game performance using a

larger sample, irrespective of performance measure (i.e., accuracy or in-game), rather than a single-case design. In combination, using a PPR appears to help improve performance accuracy and enhance in-game performance, as it acts as a mechanism for athletes to focus attention for accuracy and within competition.

Qualitative Effects

The quantitative results may be explained through the qualitative data, which indicated that although the PPR and POST affected performance through similar mechanisms (i.e., attentional and emotional control, self-awareness, self-confidence, and motivation) the exceptions were that the PPR (only) engendered a state of readiness and perceived control. As such, the PPR specifically prevented the participants from rushing the execution of their skill, enabled the planning of their response to the task, and allowed appropriate emotional adjustments to be made. Thus, as explained through Baumeister's (1997) work, the PPR in particular, affords athletes an opportunity to self-regulate, and organize the thoughts, feelings and actions required for optimizing psychological state and performance outcome. Moreover, the PPR was exclusively found to increase the participants' sense of perceived control prior to the task. This result is important, for a sense of perceive control over emotions and the environmental demands (see Chen & Singer, 2002) is known to encourage clutch performance (Otten, 2009), alleviate performance failure (Hill et al., 2011), and may allow athletes to manage their anxiety symptoms more effectively (Hanton, O'Brien, & Mellalieu, 2003). All of which are apparent in this study.

Irrespective of group allocation, participants perceived the PPR and POST enhanced in-game performance as a result of improved consistency. That is, fluctuations in performance levels were minimized, and there appeared to be less 'catastrophic' performances. Therefore, although the study does support the claim that performance routines are effective in improving performance under perceived pressure, it identifies this may be achieved principally through the maintenance of expected performance standards *throughout* the game / competition.

1 The qualitative data revealed that for the most part, performance effects were perceived to
2 be due to enhanced attentional control. That is, the PPR and POST enabled the athletes to focus
3 on the task at hand, re-focus in between shots / games, and block distractors (e.g., organizational
4 and competitive stressors). Such positive performance effects for the current study support other
5 researchers (e.g., Cohn et al., 1990; Cotterill et al., 2010) findings regarding attentional control.
6 Critically, the PPR was also considered to encourage an external-narrow focus on the target,
7 which is necessary for optimizing performance (Wulf, Shea, & Park, 2001). Moreover, the PPR
8 also prevented certain participants from focusing on, and adjusting their technique during skill
9 execution. With explicit monitoring associated strongly with choking under pressure (see
10 Beilock & Gray, 2007), this finding indicates that a PPR may be of use to athletes vulnerable to
11 choking (Hill et al., 2011; Mesagno et al., 2008; Mesagno & Mullane-Grant, 2010). Using a PPR
12 to prevent choking via the explicit monitoring hypothesis is a new suggestion / finding to current
13 theory matched choking intervention research, which indicates that a PPR should mainly be used
14 for athletes who experience choking through distraction-based models (Mesagno et al., 2008;
15 Mesagno & Mullane-Grant, 2010). While the POST preserved a task focus during performance,
16 it was identified as being a particularly important tool in the maintenance of attention after a
17 performance error. This finding is similar to Hill et al. (2010), who also found that a POST
18 enhanced attention after a performance error within their sample of golfers.

19 Several participants however, found implementing the performance routines distracting
20 during the first two weeks (approximately) of competition, and so initially, the performance
21 routines were perceived to influence performance detrimentally. This was particularly relevant
22 for the combined group because the information being learned was twice that of other groups.
23 Accordingly, having to learn both routines simultaneously might have been overwhelming for
24 the athletes. This is similar to Hill et al. (2011), whose participants took approximately four
25 weeks to implement fully a pre- and post-performance routine, along with several other strategies
26 (e.g., imagery). In contrast, however, Mesagno and colleagues (Mesagno et al., 2008; Mesagno

1 & Mullane-Grant, 2010) found immediate performance accuracy under pressure for participants
2 who were only provided a short (i.e., less than 30 minutes) performance routine training session.
3 It is possible that in the current study, the use of a recorded message on an Ipod (to prompt
4 completion of the performance routine), may have been distracting initially, and caused a
5 delayed learning response. Practitioners should therefore, remain mindful of this response when
6 introducing performance routines to athletes, and ensure the strategy is embedded fully prior to
7 competition. Moreover, other forms of routine delivery should be considered that may include an
8 imagery script or video observation.

9 Both the PPR and POST were considered by participants to facilitate emotional control,
10 which contributed to their improved in-game performance under perceived pressure. Both
11 routines appeared to encourage positive affect and minimize negative affect. Namely, the PPR
12 was effective in lowering participants' arousal levels and increasing relaxation (Boutcher &
13 Crews, 1987), while also reducing the intensity of their anxiety symptoms by promoting a task-
14 focus that blocked anxiety-related cognitions / emotions (see Hazell, Cotterill, & Hill, 2014).
15 Importantly, however, this study identified the critical role that the POST plays in controlling
16 emotions effectively after a performance error, by preventing frustration in particular. As such,
17 an immediate constructive reflection of errors may improve performance, not just as a result of
18 informing relevant technical adjustments required, but also through the maintenance of
19 emotional control.

20 The PPR was perceived to improve participants' performance within the current study
21 through perceptions of enhanced self-confidence, which supports other researcher's findings
22 (e.g., Cohn et al., 1990). The PPR and POST both led to raised expectations of successful
23 performance as participants began to trust the routines would facilitate effective in-game
24 performance. Subsequently, it appeared that participants became more focused on executing the
25 routines during performance, and less concerned with the performance outcome. It can be
26 inferred therefore, that the PPR and POST may have afforded higher levels of confidence as a

1 result of the sense of control gained over their performance, through achieving a more process,
2 rather than outcome focus (see Kingston & Wilson, 2009). In addition, similarly to Hill et al.
3 (2010), this study found the POST protected the participants' self-confidence, by ensuring the
4 reflection of errors was constructive, and so self-criticism was minimized.

5 With the exception of Beauchamp et al. (1996), the impact of performance routines on
6 motivation has received limited research attention. The findings from this study offer an
7 indication that both the PPR and POST may enhance athletes' levels of motivation, which
8 manifests itself with increased persistence after errors. In this case, participants chose to persist,
9 rather than withdraw effort after mistakes because the routine provided them with a focus they
10 considered could help regain performance standards.

11 Finally, an interesting finding was that several participants acknowledged that the routines,
12 and in particular the POST, encouraged a greater level of self-awareness. They were able to
13 recognize, through constructive reflection, the reasons for performance errors, and thus their
14 technical adjustments were more effective and performance improved subsequently. This finding
15 appears to align with Zimmerman's self-regulation theory (2000), which suggests there are three
16 cyclical phases of self-regulation; namely, a forethought phase (goal setting and planning), a
17 performance phase (using strategies to improve learning), and a reflection phase (adopting
18 strategies to evaluate different parts of the performance after learning). It is acknowledged that
19 each phase will encourage individuals to become increasingly self-aware, goal-oriented, and
20 problem-focused, and more likely to achieve their goals as a result. Thus, whilst the POST was
21 designed initially to encourage reflection (only) within the current study, it would appear it also
22 stimulated participants to engage with the forethought and performance phase, and thereby
23 encourage effective self-regulation and the development of sporting expertise (see Kitsantas &
24 Zimmerman, 2002).

25 As an aside, while it may be suggested that raised self-awareness can induce choking
26 through explicit monitoring, it was not found to be the case within this study (indirectly from the

interviews). As summarized by Carr (in press), post-performance reflection may aid the performance of an established (i.e., automatic) skill, if it is aimed specifically at repairing technical and / or performance errors. Moreover, and critically, the post-performance routine adopted within the current study was designed to encourage focus on target alignment adjustments prior to the skill execution, and therefore was unlikely to interfere with skill execution.

Limitations and Future Research

We attempted to control for confounding variables, however, we understand there may be some limitations, which researchers should consider when exploring the effect of routines on athletic performance in future. Firstly, the number of league games obtained may not provide an accurate determination of league averages. Tenpin Bowling Australia guidelines indicate that 24 games is an appropriate number of games to establish a reliable league average, however, we decided on 12 games because we wanted the number of league games and intervention games to be consistent. Secondly, it is possible that the use of an Ipod with a recorded message of the performance routine(s) from the lead author, may have delayed participant learning and encouraged distraction initially. Researchers should consider asking participants to generate their own voice recording to prompt each stage of their PPR and POST to decrease distraction. Thirdly, it became apparent during the interviews that participants within the PPR and POST groups had also spontaneously adopted POST and PPR's, respectively. Indeed, it is highly likely that the control group also contained individuals who possessed their own PPR and POST. Therefore, it remains challenging to establish objectively and with certainty, the extent / size of effect that each discrete routine had on performance. However, in this study, the qualitative data identified a distinctive perceived effect the PPR and POST had on performance, reinforcing the advantages of the mixed method approach adopted. Finally, prior to data collection, an a priori power analysis was conducted using G-Power 3 (Faul, Erdfelder, Lang, & Buchner, 2007) to determine the sample size necessary for adequate statistical power. To gain a medium effect size

(0.25) with 80% power and alpha level of .05, a total of 40 participants were required. Due to logistical reasons (and injuries during the study), however, we were unable to obtain more participants than included in the current study. Since some statistical tests (especially related to performance) were non-significant with a moderate to large effect size (Cohen, 1988), a post-hoc power analysis was conducted to assess the statistical power with the reduced sample, which indicated that for an effect size of 0.25, with a sample of 33 participants, 70% power was obtained. While this does not reach the desirable 80% power level, we feel that the results still provide an indication of the practical effects of the routines in this study, however, we understand that future research is needed to further verify these results.

Future research should continue to investigate PPR, but also expand the POST literature. For example, a clearer understanding of whether POST are used (and their function) in sport generally to differentiate their benefits. Furthermore, it is not possible to generalize these POST findings, and to assume the same routine can impact athletic performance within other sports, considering this was a bowling specific POST. Thus, future research could differentiate between the effectiveness of other POSTs such as those using behaviours, other cognitions, or emotional regulation. It is also conceivable that pre-and post-performance routines should be individualized further, in order to achieve optimal benefit.

Summary and Conclusion

The current study was the first to investigate quantitative and qualitative differences in PPR and POST training on accuracy and in-game performance. This unique mixed-method design contributes considerably to the extant literature by providing further evidence that both PPR and POST training can improve performance standards within real-world (arguably more pressurized) situations. Furthermore, we have extended the PPR literature to include POST training as a means of improving in-game performance, even though this sport-specific PPR did not improve accuracy. We found additional evidence that PPR are effective in improving, but extended this to confirm that in-game performance was improved through an improvement in

1 increased accuracy. The qualitative data has provided an indication of the mechanisms which
2 were responsible for this effect. That is, both the PPR and POST enhanced performance through
3 increased consistency, which was the result of improving the participants' focus, emotional
4 control, self-confidence, motivation and self-awareness. Accordingly, the findings of this study
5 can be of considerable value to practitioners working with athletes who perform under
6 competitive pressure.

7

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16

1 Table 1.
 2 *Mean and Standard Deviation (SD) for accuracy (Mean Absolute Error- MAE) and in-game*
 3 *performance scores (league average) pre- and post- intervention for the different groups.*

Group	Reported League Average (SD)	Pre- intervention MAE (SD)	Post- intervention MAE (SD)	Mean (SD)- Pre- intervention league	Mean (SD)- Post- intervention league	Mean (SD)- Follow-up intervention league
Combined	179.00	4.01	3.47	177.39	187.36	183.81
	(16.09)	(1.62)	(1.43)	(18.68)	(17.85)	(10.69)
PPR	179.86	3.40	2.69	180.10	190.29	191.24
	(23.60)	(1.08)	(0.60)	(29.12)	(19.84)	(20.84)
POST	177.38	2.97	3.24	179.38	181.39	185.06
	(10.99)	(0.47)	(0.84)	(6.30)	(6.06)	(12.30)
Control	179.89	3.54	3.30	181.26	180.95	179.56
	(17.10)	(0.84)	(0.78)	(22.99)	(22.35)	(21.99)

1 Table 2.

2 *The perceived effects of the PPR.*

Overarching Category	Codes
	Perceived improvements
<i>Performance</i>	Increased consistency of performance, thoughts and emotions
	Negative impact [predominantly short-term]
<i>Attentional and Emotional Control</i>	Blocked / alleviated negative emotions
	Improved task-related focus
	Relaxation / lowered anxiety
<i>Self-Awareness</i>	Increased ability to recognize and correct errors
	Re-evaluate / recognition of mental training
<i>Self-Confidence</i>	Raised performance expectations
	Performance resilience
<i>State of Readiness</i>	Slowed preparation and execution
	Enabled planned skill execution
	Emotional regulation
<i>Motivation</i>	Increased persistence and effort
<i>Perceived Control</i>	Over self, emotions an performance

3

1 Table 3.

2 *The perceived effects of the POST.*

Overarching Category	Codes
<i>Performance</i>	Perceived improvements
	Increased consistency of performance, thoughts and emotions
	Effective / efficient technical adjustments
	Negative impact [short-term]
<i>Attentional and Emotional Control</i>	Improved task and process -related focus
	Blocked / alleviated negative emotions
	Relaxation / lowered anxiety
<i>Self-Awareness</i>	Increased ability to recognize and correct errors
	Recognize how to self-develop
<i>Self-Confidence</i>	Raised performance expectations
	Constructive post-error reflection
<i>Motivation</i>	Increased persistence and effort

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